FENCING ENHANCES SHRUB SURVIVAL AND GROWTH FOR MOJAVE DESERT REVEGETATION

R. B. Hunter[1], A. Wallace[1], and E. M. Romney[1]

Abstract.— Fourteen species of native shrubs were transplanted to bare areas of the northern Mojave Desert in 1972 and 1973. By 1978 plants surrounded by small fences were larger (0.26 vs 0.11 m^3 overall average for several species) and survived better (42 percent versus 23 percent) than unfenced plants. These effects are primarily due to reduced grazing of shoots. Loss of shrubs to pocket gophers or other burrowing rodents was not prevented by fencing.

Natural revegetation of disturbed desert lands is a very slow process (Shreve 1917, Shreve and Hinckley 1937, Wells 1961, Shields and Wells 1963, Wallace et al. 1977). Seeding and transplanting of shrubs have often failed as the result of problems such as poor germination, poor growing conditions, grazing by rodents, and inadequate soil preparation (Graves 1976).

Transplanting *Atriplex canescens* (Pursh) Nutt. onto desert lands has been successful in several instances (Springfield 1970, Aldon 1972, Cable 1972, Nemati 1977). Much effort has been put into timing for maximum availability of soil moisture. Our experience with transplants watered through the first summer of growth showed more persistent problems related to grazing and pruning by rabbits and smaller rodents than to drought conditions. The grazing problem has been noted by others working with *A. canescens* (Springfield 1970, Cable 1972, Graves 1976, Shetron and Carroll 1977).

Materials and Methods

On 16 February 1972, 100 shrubs of 14 species (Table 1) were transplanted from a glasshouse to a 29 ha bare area in a natural Mojave Desert shrub community on the Nevada Test Site (Frenchman Flat). Each plant in three of eight rows was enclosed within a fence of about 0.5 m diameter of 2.5 cm mesh chicken wire (Fig. 1). Each fence was supported by three lath stakes. All plants were watered monthly through the following summer (10 to 20 liters of water per plant per month).

On 16 February 1973, 62 additional plants representing seven of the species listed in Table 1 were transplanted to a nearby site similarly devoid of shrubs. Three of nine rows were fenced, and the transplanted shrubs were watered through the summer of 1973 in amounts indicated above.

Surviving plants were recorded 31 May 1973, 15 February 1977, and were counted and measured 7 June 1978. Plant volumes were calculated from the height and the average of two width measurements, assuming a cylindrical shape.

A further planting of 381 plants of assorted species in 127 groups of three was made 7 May 1977 in a nearby area where much of the surface had been removed for gravel. All plants were fenced and watered every 4 to 6 weeks through August 1977.

Results and Discussion

Table 1 reports survival of shrubs at the three census periods for the 1972 and 1973 plantings. By 1978 only four unfenced species survived [*Ambrosia dumosa* (A. Gray) Payne, *A. canescens*, *Larrea tridentata* (Sesse & Moc. ex DC) Cov., and *Lycium andersonii* (A. Gray)]. In contrast, nine fenced species survived. Overall survival rates were marginally improved by fencing.

[1]Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles, California 90024.

Prevention of grazing resulted in greater size of fenced plants (Table 2, Fig. 1). When calculated as percent of average size for each species, the fenced shrubs were significantly larger ($P < 0.05$) than unfenced shrubs.

Failure of shrubs to survive seems to be related primarily to rodent browsing and pruning activity, although a few species may have succumbed to weather and transplant shock [*Salvia sonomensis* (Kell.), *Salazaria mexicana* Torr. and *Stephanomeria pauciflora* (Torr.) Nutt.] Rodents in this area include pocket gophers (*Thomomys bottae*), rabbits (*Lepus californicus* and *Sylvilagus audubonii*), kangaroo rats (*Dipodomys merriami*), and mice (*Onychomys torridus* and *Peromyscus* spp.) (O'Farrell and Emery 1976).

Unfenced palatable shrubs (*Ceratoides lanata* (Pursh) J. T. Howell, *Yucca* spp., *Artemisia tridentata* Nutt.) were killed by grazing of shoots until only stubs were left. Fenced plants, however, also were killed by burrowing rodents, particularly pocket gophers (Fig. 2). Losses continued through 1978 for fenced shrubs.

Plantings made on the gravel excavation site in 1977 survived and grew very well through the first year after transplanting. Only two plants were lost, one of which appeared to be dying within a month of transplanting. Only *Atriplex* species were grazed heavily. The rocky, sandy soil appears to have discouraged burrowing rodents at that site.

Grazing of shoots appeared sporadic and heaviest when most shrubs were dormant and annual plant species were absent (summer and fall).

The fencing technique used is rapid, inexpensive, and effective against nonburrowing rodents. The particular sites planted here appear to harbor an unusual density of burrowing species (Hunter et al. 1980, this volume) seriously reducing the effectiveness of the fences.

Seed production occurred in most surviving species in 1978 (except *Coleogyne ramosissima* Torr. and *Yucca* spp.). Although natural seedling establishment normally may be severely inhibited by grazing animals, we believe that revegetation of sites disturbed by human activities would be enhanced by taking steps to protect newly developing seedlings through the use of inexpensive, fenced enclosures.

Acknowledgments

This study was supported by Contract EY-76-C-03-0012 between the U.S. Department of Energy and the University of California.

Table 1. Numbers of surviving plants transplanted to two disturbed areas in Frenchman Flat in February 1972 and February 1973. Survivors were counted May 1973, February 1977, and June 1978.

	Fenced				Unfenced			
Species*	Original	1973	1977	1978	Original	1973	1977	1978
Ambrosia dumosa	9	8	3	3	18	15	10	8
Atriplex canescens	6	5	4	4	10	9	5	5
Artemisia tridentata	3	3	3	1	6	4	1	0
Ceratoides lanata	5	3	2	2	9	1	0	0
Coleogyne ramosissima	1	1	1	1	1	0	0	0
Grayia spinosa	2	1	0	0	4	1	0	0
Larrea tridentata	10	8	6	5	16	12	11	11
Lycium andersonii	3	2	2	2	5	3	1	1
Lycium pallidum	3	1	0	0	5	0	0	0
Salvia sonomensis	3	0	0	0	6	0	0	0
Salazaria mexicana	1	0	0	0	3	1	0	0
Stephanomeria pauciflora	1	0	0	0	2	0	0	0
Yucca brevifolia	2	2	1	1	4	4	0	0
Yucca schidigera	10	10	6	6	17	16	1	0
Total survival	58	44	18	25	104	66	29	25
Percent survival		76	47	42		62	27	23

*Full names of the species will be found in text except for *Grayia spinosa* (Hook.) Moq., *Lycium pallidum* Miers, *Yucca brevifolia* Engelm. in Wats., and *Yucca schidigera* Roezl ex Ortgies.

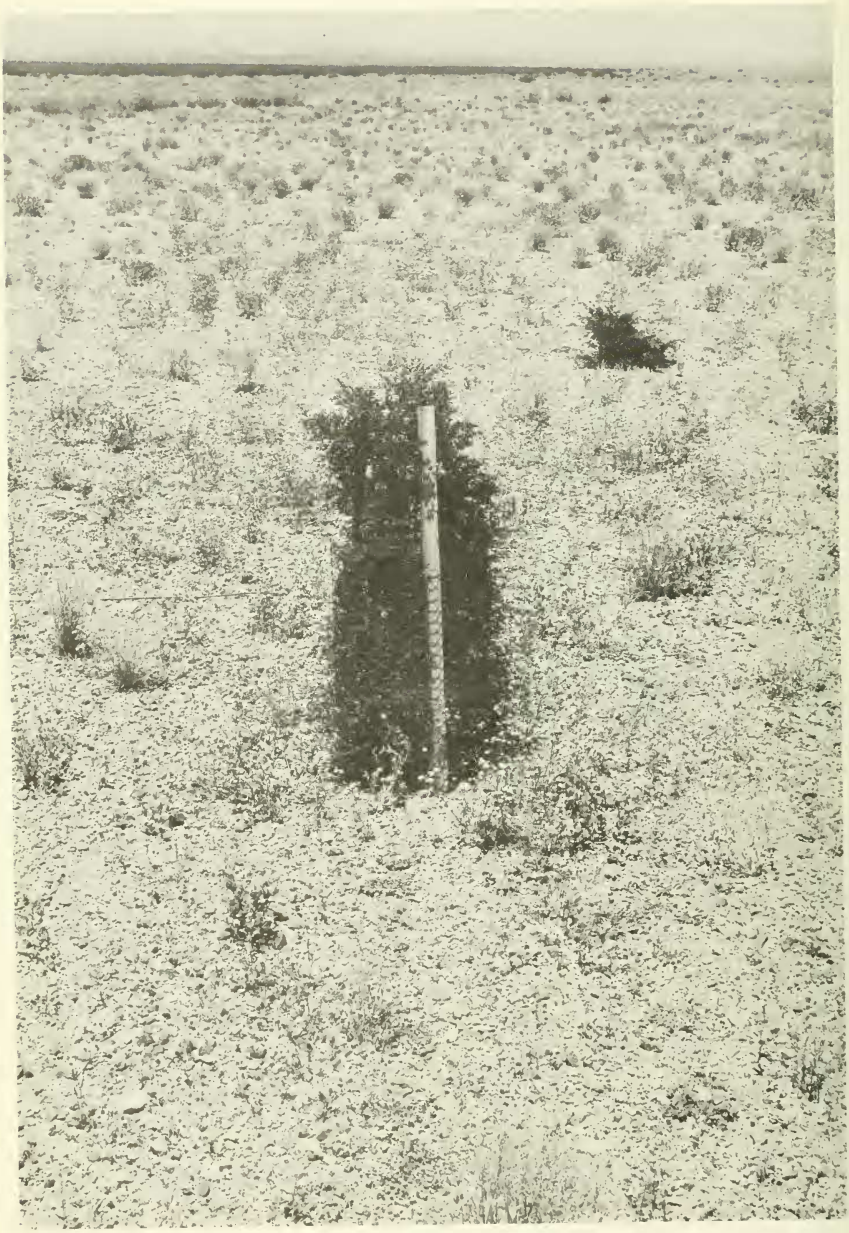

Fig. 1. Inexpensive wire enclosures protect transplanted shrubs from grazing rabbits.

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TABLE 2. Average sizes of fenced and unfenced surviving transplants, June 1978 (Vol, m^3 ± SEM).

Species	Fenced	Unfenced
Ambrosia dumosa	0.093 ± 0.017	0.050 ± 0.010
Atriplex canescens	1.064 ± 0.616	0.263 ± 0.025
Artemisia tridentata	0.108	
Ceratoides lanata	0.171 ± 0.019	
Coleogyne ramosissima	0.026	
Larrea tridentata	0.239 ± 0.087	0.089 ± 0.014
Lycium andersonii	0.022 ± 0.001	0.031
Yucca brevifolia	0.009	
Yucca schidigera	0.040 ± 0.011	
Overall average*	0.260 ± 0.115	0.109 ± 0.018

*Average of all surviving plants, numbers of each species are given in Table 1.

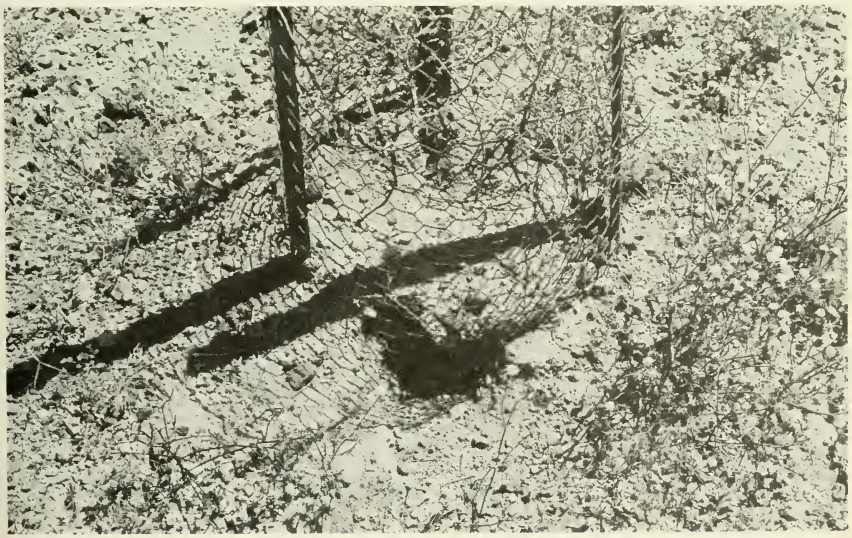

Fig. 2. Pocket gophers (*Thomomys bottae*) destroyed some transplanted shrubs initially protected with wire enclosures.